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PALEONTOLOGY AND EVOLUTION[1]

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Some especially stimulating works of paleontologists on Evolution have appeared within the past few years, two of the most recent being the great two volume "Evolution Emerging" (Gregory, 1951) and a compact little work entitled "The Dilemma of the Paleontologist," (Case, 1951).

Certain points of disagreement among evolutionary paleontologists are due to a lack of precise definitions, others to just the opposite, the attempt to make hard, fast and inflexible definitions which might be mathematically exact but cannot be maintained.

Pronouncements of various "laws" are being increasingly questioned. It is becoming clear that certain of the so-called Laws of Evolution are, as usually stated, only broad generalizations and not laws at all. One effort of this paper is to examine and restate some of these generalizations, and attempt to restate them in such a way as to take care of the various exceptions that plague the evolutionist.

In this effort I have attempted to tell something of the limitations of the field of paleontology and then go on into a discussion of general aspects of evolution from the viewpoint of the paleontologist, and especially to give attention to a rather neglected theory of evolution.

My particular field is the invertebrate life of the Paleozoic, especially the older Paleozoic. In my younger, more optimistic and probably more credulous days I rather naturally assumed that if you had four successive geological formations the first carried fossils ancestral to the second, the second carried the direct ancestors of the third, and the third had the progenitors of the fourth. But it isn't nearly as simple as that. No one of the three earlier would necessarily be ancestral to any one of the later.

Throughout geologic time the continents have been going through what may fairly enough be described as a slow motion shimmy, if the Academy remembers that early one of the modern eccentric dances. Every time our North American continent dipped down in a given direction, the epeiric seas flooded in over the depressed land as epicontinental seas, covering greater or lesser areas and usually following rather definite patterns. Depression toward the north would bring in an Arctic marine embayment and a fauna which would be quite different from such an invasion from the Gulf to the south, and both would differ from an invasion from the North Atlantic. In the older formations of Ohio just exactly these events happened, there being a rhythmic alternation between southern or Gulf faunas and northern faunas which came either from the North Atlantic or the Arctic.

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A recurrent invasion from a permanent oceanic basin, would bring back a recurrent fauna. Within such an embayment there may commonly be smaller faunal movements to and fro following shifts in the nature of the environment. In other words, migration may have as its basis either changes in the geographic pattern or in physical conditions of the environment.

We have in the recurrent faunas from a given basin a periodic view of what changes are at work upon various species. Any study of evolutionary paths must be restricted to such recurrent faunas.

Many such recurrences are known. The great Richmond invasions, so conspicuous in the Cincinnati province, are Black-River-Trenton recurrences after a lapse of probably twenty million years. Another case is the middle Ordovician Catheys-Millersburg fauna which recurs in the upper Ordovician Maysville after an interval of probably twelve million years. The lower Devonian Helderberg fauna is a recurrence of the middle Silurian Waldron fauna. In the upper Devonian are four successive recurrences of the middle Devonian Hamilton fauna. Ulrich (1911) lists five, possibly six, recurrences of the Salem or Spergen fauna.

A surprising thing about these recurrent faunas is the relatively slight amount of change between an invading species and its recurrent form. The static nature of invertebrate life is quite amazing. In the recurrent Richmond faunas 21 species are listed as being so nearly like their Black-River-Trenton ancestors as to be unable of differentiation, while it takes keen discrimination to distinguish between some of the other species. The same is true of the other cases listed.

That life, at least marine invertebrate life, is static for long periods of time is further shown by the fact that many modern mollusca go back without change to the Miocene, ten to twenty-five million years ago. Yet vertebrate life during this same lapse of time has evolved tremendously.

It is true that there have been times in the past history of the earth when evolution has apparently been quite dynamic, times when there appeared to be a veritable explosion of new types. A few of these cases do show detailed examples of very rapid and diverse evolution, as Fenton's Spirifers (Fenton, 1931) and the recurrent Tropidoleptus zones of the upper Devonian as indicated by Williams. But some of the most conspicuous examples are doubtful. Times of apparent rapid evolution are the transition from Paleozoic life to that of the Mesozoic, and that from the Mesozoic into that of the Cenozoic. They may be explained in part by the principle of adaptive radiation, but it is a question as to whether or not the real evolutionary foundation of such apparently rapid specialization had not already been built. In other words, the apparently rapid evolution of a new type may actually be due to new opportunities opening up for the rapid expansion of a specialization which had been undergoing development for a long time previously.

Actually, there is so very little that we know about the life of the older geological formations. As an example, the Cincinnatian rocks of Ohio have been a remarkably productive source of superlatively preserved examples of Ordovician fossils. Thousands of people for upwards of a century and a half have searched out specimens of the ancient life so abundantly preserved, yet new species are turning up every year, some of them of most amazing types. Yet we know nothing of any land life, though there must have been plants and primitive terrestrial arthropods. Nor do we know of any foraminifera, nor any ostracoderms, both known elsewhere. We know very little about the ancestors of the hundreds of Cincinnatian species.

Judging by the slowness with which marine invertebrate life changes, it is probably true that more than half of the fossilizable life record of the Paleozoic is lost in the unconformities between the different systems, while half of what is left is missing during the time of the unconformities within the systems, during

which times the continents were elevated and undergoing erosion while the deposition containing the record of life was off the continental limits and out along the edges of the permanent oceanic basins where it is inaccessible to us.

Thus we find that according to the record not a single Cambrian species lived beyond the break into the Ordovician, nor did a single lower Ordovician species live on into the middle Ordovician. Similarly, in Ohio, not a single species of the prolific Ordovician faunas is found above in the Silurian. When the Silurian seas came in the life was just 100% different. And faunal breaks of almost the same magnitude occur through the whole of the Paleozoic.

This does not mean that there was a complete evolution of new life during the time represented by the missing record of the unconformity. We are just beginning to appreciate the fact that while forms of life may seem of sudden origin, it is only their appearance that is sudden, for they may have had a long ancestry elsewhere where the record has been lost or is inaccessible, or it may be that they have not as yet been found.

Some decades ago the chain coral Halysites was considered to be an excellent and dependable index fossil of the Silurian. How Halysites is known from as far down as the middle Ordovician Black River, with a half dozen or more species from the upper Ordovician or Richmond.

The cystoid order Diploporita, in the light of our knowledge a few years ago, was limited to the Silurian. Now we have a form, Eumorphocystis, which carries the order Diploporita back to the Black River of the Middle Ordovician.

Several decades ago a species of the ostracode genus Aechmina was found at the top of the Richmond. To the late E. O. Ulrich, who at that time was attempting to establish the thesis that the Richmond was Silurian instead of Ordovician, this fact was highly significant, since to him Aechmina was an index genus of the Silurian and Devonian. But since Aechmina has been found down into the Stones River, through a total range of about two-thirds of the Ordovician. And there is every expectation of the genus being found still lower, since in the Stones River it is quite as distinct as in the Silurian and Devonian.

When there is so very much that we don't know and when there is so very much that might be discovered by intelligent and diligent searching in the field, one is likely to become impatient at the collectively very great but relatively sterile efforts involved in the laboratory splitting of fossil species and in some of the statistical approaches to sedimentation. Knotty points of nomenclature and priority must be settled, certainly, but it is of far greater importance to explore into the unknown.

Modern taxonomists in both Botany and Zoology have their difficulties with "splitters," but paleontologists are away ahead of them, for they may not only describe facies adaptations as species, but they may also add specific and even generic distinctions based on the degree of preservation of parts which may be preserved by silicification but are absent in the ordinary calcareous expression of the fossil.

If there has been evolution, and in the middle of this 20th century I do not see how any rational individual can deny it, then it must follow that in the paleontologic record we should find specimens intermediate between one species and another, one genus and another, one family and another, and so on. In the older Paleozoic there are relatively few such transitions, probably due to the incompleteness of the record as previously explained. But these transitions do occur and are abundantly shown in the Foraminifera, and in a lesser degree in the Bryozoa, Brachipoda, Ostracoda, etc.

This poses a special dilemma for the beginning student of Paleontology, who always expects to find rigid boundaries between different species and genera. Thus, in the bryozoan family Heterotrypidae we find four genera that, while

normally good workable groups, in one species or another each genus tends to overlap the characters of each of the other three.

Having examined some of the limitations of Paleontology with respect to Evolution, we are ready to test some of the evolutionary generalizations. In testing these it must be admitted that, because of the scantiness of the early record, and the very slow progress of evolution, the complications of different migrating faunas from different sources, and the further complications of facies adjustments, invertebrate paleontology has special weaknesses. Vertebrate Paleontology presents the very best material for the testing of evolutionary generalizations where the record is abundantly enough preserved to trace migrations more or less confidently as well as trace the evolutionary changes.

Before examining some of these generalizations we must agree upon a more exact usage of certain terms than the current usage, which has lead to considerable confusion. While very elementary, the next few statements are too often forgotten or overlooked.

Any evolution away from the primitive condition of an organism is specialization, whether that evolution be specialization by addition of something not possessed by the primitive type, or by the reduction of something present in the primitive type.

The term progressive has been usually applied to those cases where there has been a more or less steady specialization such as the steady reduction of the side toes and premolar #1 of the horse. But since these cases are retrogressive in the sense that they constitute a loss of structures which had previously been developed, they could with equal logic be called retrogressive. Specialization by reduction is applicable to the reduction or loss of toes, leg bones and premolar #1 of the horse, but the addition of new cusps beyond those of the Eohippus molars would be specialization by addition. In either case it is progressive, not meaning to infer that progressive means a change leading to a greater potential adaptability and hence greater opportunity for the organism. Whether a given specialization renders an organism more successful or less so is a criterion commonly used, but temporary success may mean ultimate failure.

It may be mentioned that with few exceptions mammalian evolution since the Paleocene has been specialization by reduction, mostly of the teeth, toes and leg bones. Most cases of specialization by addition have been in the development of horns, and in the increase in the number of teeth and phalanges in the Cetacea.

STATIC (ARRESTED) EVOLUTION

A popular belief is that life cannot stand still, it must either progress or die. Progression, in this case, is change, or what we have just defined as specialization, whether forward or backward.

Many years ago Ruedemann, in his address as president of the Paleontological Society, took as his title "The Paleontology of Arrested Evolution" (Ruedemann, 1916). It is true that refinements in classification have somewhat reduced the examples he cited. But the point remains that, whether parts of a species be split off and called varieties, subspecies or valid species, and parts of a genus be split off and called subgenera or valid genera, the morphological points of difference have usually been very small. In other words, the change from the early expression of the group to the latest is of small taxonomic value.

The geologic record is full of cases where a given group persists for a long time, and successfully, if judged by the numbers of individuals, in competition with the associated fauna. Many long lived forms seem to have lost practically all capacity to change, and have become quite static. The present day "living fossils" are striking refutations of the popular belief that life cannot be static, and these examples range from Foraminifera to Mammalia.

DOLLO'S LAW

Dollo's "Law of the Irreversibility of Evolution" has been quite generally accepted by biologists, and especially by vertebrate paleontologists. But these latter are beginning to discover what the invertebrate paleontologist has long known, which is that if the so-called Law is meant to cover evolutionary changes in size, shape, and proportion, then there are numerous exceptions to it. And, if there be exceptions, then it cannot be called a Law.

A much better statement, and one which might fairly be called a Law, would be this—An organ or part once racially lost is never racially regained.

We do have the individual return of structures which have been racially lost, but never a racial return. Here belong those cases of known atavisms, such as the zebroid coat pattern, the return of the side toes, and the return of premolar #1, the so-called wolf tooth in the modern horse. Since these appear most commonly in mongrel stock it would seem that their original disappearance was due to the gradual separation of genes where all of a certain number were required for the expression of the character. Should all be brought together again, the structure reappears.

To me one of the great mysteries of life is the way that any established group is always trying to be something different. By "trying" I do not mean consciously trying. Crinoids started out as typical Pelmatozoa with a solidly attached base on the distal end of the stalk. Many of them became free from the basal attachment but still kept trying to fasten themselves to the bottom. A half dozen different devices have been developed for anchoring the animal after it had become free.

The brachipods show the same indecision, never having decided whether to be free or attached. Whatever they are they seem always to be trying to be something else. A pedicle and pedicle opening are evolved, then in three or four different ways brachiopods attempt to close up the opening. Having freed themselves from the danger of being confined to one spot, with the attendant danger of burial in the sediments, they begin to fasten themselves down again by various cementation and spinose devices.

Among the molluscs we find the most striking cases—clams attempting to become snails (Exogyra), brachiopods (Spondylus), worms (Teredo), or corals (Rudistids). And the snails start out with a capulid type of shell, then most of them evolve a more or less high spired and compactly coiled shell, then some of those that have evolved such a shell tend to uncoil (Vermicularia) and return to primitive simplicity (Crucibulum), living more or less prosperously right along with those that have evolved compact spires. If there be any special virtue in the primitive condition, why not remain that way? Why should they evolve? If there be any special value in a tightly coiled shell, why didn't they stay that way instead of returning to primitive simplicity? And how explain why primitively simple species, specialized species, and secondarily simple species all live and thrive together through the ages and in the same environment?

The cephalopods include perhaps the best cases of exceptions to Dollo's "law," as that is usually stated. In many different lines of descent and very early in their record the primitive Nautiloidea leave the straight or slightly curved shell and evolve a more or less tightly coiled shell. But very soon (Lituitidae in the Ordovician, Ophidioceratidae in the Silurian) in at least two lines of descent the completely coiled forms begin to straighten out again, and in the Mesozoic at least two more families (Cosmoceratidae and Lytoceratidae) do the same thing. The argument applied to the gastropods applies equally well here.

THE BIOGENETIC LAW

The four so-called "laws" of Von Baer were condensed by Haeckel into the simple statement that "every animal in the course of its individual existence *tends* to recapitulate the development of the race." This has been accepted by biologists as "The Biogenetic Law." Unquestioned for the better part of a century, it has been vigorously attacked in recent years. Perhaps the heaviest attack has been by G. R. de Beer (1930) whose ideas have been more or less adopted by some paleontologists. For example, E. C. Case (1951, pp. 188–192) objects that "critical examination has shown that it can be substantiated in only a very general way." But that is precisely what is recognized in Haeckel's statement, for he states that the organism "*tends* to recapitulate," and a recapitulation is only a generalized and much condensed summary, and it doesn't follow that the recapitulation is a detailed one for each organ or part. This is a common inference among my students, and they seem downright disappointed to learn that in the human embryo gill slits, a three chambered heart and an ichthyopsidan urogenital system are not correlated with gill filaments and scales on the outer epidermis.

If the Biogenetic Law be stated in inflexible terms as "the development of each organ or part of each species through the same stages in its embryology that were passed through in the evolution of the race" as seems to be implied in some of the criticisms, then the vigorous attacks can be well justified, since there will be numerous exceptions.

Some of the critics seem to have overlooked the principle of caenogenesis, so conspicuously demonstrated in the higher orders of insects, where the early developmental stages are obscured by the extreme secondary specialization involved in the development of a larval stage, yet the highly specialized wing venation follows an excellent pattern of development according to the Biogenetic Law.

METHOD OF EVOLUTION

The problem of the method of evolution is one where paleontology can furnish especially weighty evidence in some respects, but is peculiarly weak in others. The evidence that evolution has taken place may be quite clear, but how and why that evolution happened is another matter. Thus, in the generally accepted Mutation Theory, Paleontology is quite unable to offer any evidence for or against it. A sudden specialization appears in the record, but it might be a form which had developed in some unknown way elsewhere and has migrated into the place where found, or there might be a break in the record where a slow transition is missing, or it might be a veritable mutant. There is no possible means of identifying a valid mutation.

In the last analysis both Lamarckian Evolution and Darwinian Evolution are based upon utility, upon the value to the species of some specialization. Neither could possibly explain the development of useless structures, the final disappearance of vestigial structures, and the development of the numerous cases of overspecialization that litter the geological record. Neither could explain the development of the second upper incisor of the Proboscidea beyond the point of maximum efficiency, for the same factors which would push the development of the tusks up to the point of maximum efficiency would pull back any specialization beyond that point. But the development of tusks went right on past their point of maximum value as weapons of offense and defense, or as tools used for digging up roots and tubers, and became useless because ultimately they formed great ivory loops with the points turned back toward the skull. As such they were not only useless, which means an economic waste of building material, but a continuous drain on the resources of the individual for repairs and upkeep, and another very real drain on the resources of the individual just to carry them around.

Whatever type of Evolution was responsible for the development of the tusks beyond the point of maximum efficiency, in some cases more than 50% of the whole evolution, that type must have also been responsible for the earlier evolution.

This argument applies equally well to many brachiopods and molluscs, especially cephalopods, and to spinose trilobites, over-armored dinosaurs, sabre-toothed cats, etc.

In the disappearance of vestigials a current Neo-Darwinian argument would explain it by the process of what has been called microselection of micromutations. But here we have a paradox that seems difficult to accept. The idea that microselection would eliminate a certain tiny vestigial structure, and eliminate it because it was no longer of value to the possessor, and at the same time get behind another certain tiny structure not yet developed to the point where it had any selective value, and push it on into a condition of value, seems quite inconsistent when neither has any actual value.

The possession of a vestigial tooth, toe, leg bone, or whatever may be regarded as of negative selective value because the structure is microscopically harmful to the possessor, involving a microscopic economic loss for its construction, maintenance and transportation. If this were the only structure involved in the process of selection that might be possible, but survival is not that simple. Every organ or part or superficial character possessed by an organism may be of equal or greater value than the one considered, and may vary both structurally and physiologically and at the same time. This is the old "swamping out" objection, but it is still a valid objection.

To believe that selection, micro or otherwise, could completely eliminate the vestigal lower tusks of the Mastodon-Stegodon-Archidiskodon lineage, while at the same time adding the incipient new cusps to the back of the molars, when neither had any apparent selective value, is an illustration of what I mean. The reduction and ultimate disappearance of premolar #1 of the horse lineage, while simultaneously adding incipient new structures to the other teeth, is another example, typical of many such. Which brings us up to the consideration of a fourth method of evolution, Orthogenesis.

ORTHOGENESIS

This explanation is not held in very good repute by evolutionists, and goes by a variety of names, but admitting of certain variations in the mechanism, these terms may fairly enough be lumped together as Orthogenesis. Some of these synonyms or related terms are aristogenesis, autogenesis, bathmism, elan vital, entelechy, inner principle of progressive development, nomogenesis, ortho-selection, rectigradation, and vitalism. Orthogenesis covers all those numerous cases where a certain specialization begins and progresses more or less steadily in a given direction to a maximum of change. Such specializations continue through shifting environments for tens or scores of millions of years, apparently largely independently of both environment and selection so far as the motivating causes are concerned.

Illustrations usually given are the evolution of the horse, elephant, camel, etc., but many other more or less well-developed cases are known in both vertebrate and invertebrate paleontology.

The objection has been raised that any detailed line of descent will appear to be orthogenetic whatever may have been the cause of the progressive change. Whether or not it really is and how to tell the real from the spurious is a question. Possible criteria testing such cases would be the following.

1—The steady reduction of vestigials, as previously discussed.

2—Overspecialization, as previously discussed.

3—Evolution of useless characters.

4—Evolution persisting along a straight line through changing environments.
5—The same modification appearing in closely related pedigrees but at different times and under different environmental conditions.

The evidence presented for the disappearance of vestigials is all evidence in support of orthogenesis. To examine vestigials a bit further, the horse's premolar #1 can be matched by hundreds of similar examples. The human molar #3 or wisdom tooth is an excellent example of what I mean. It is going, and has been going since at least the close of the Pliocene which was conservatively about a million years ago. The smaller, less well enameled molar #3 is one of the dependable characters separating the Simiidae from the Hominidae. And it is going, just as did the premolar #1 of the horse. It is a ghastly thought to consider that the horse took the better part of 50 million years to completely lose his first premolar, and then think ahead to the future of the human species.

But why is the third molar going? In all types of environment from arctic ice to the tropical rain forests, in deserts, plains and mountains, from the Esquimaux and Australian to the most developed and sophisticated peoples, molar #3 is going. In skulls of prehistoric Indians and Mound Builders, some of whom had used their teeth until they must have been worn down almost to the gum, the wisdom teeth are reduced. It doesn't seem reasonable to believe that micromutants, or by whatever name they may be called, would be of selective value in reducing the teeth and so conserving building material when it would be more logical that selection pressure would be in the opposite direction, with greater value in the strengthening of the wisdom teeth so as to avoid many of the liabilities of having them as they are. There is to be sure the problem of impaction due to the shortening of the human jaw, but that is another example of Orthogenesis. Early Homo sapiens, as well as races living under primitive conditions where the teeth and jaws are much used, all show some shortening.

If all of these modifications have been by mutations, the separate mutations have been so tiny as to be individually unrecognizable. This could have been, since cumulative mutations would be orthogenetic mutations, there being nothing incompatible between Mutation and Orthogenesis. Cumulative mutations are of the types shown by improved varieties of sweet peas, dahlias, Shasta daisies, etc., among the plants, and pigeons and ostriches among the animals.

One of the most convincing proofs of Evolution is to be found in the field of Comparative Anatomy, using as evidence the urogenital systems. Either we have the replacement of the primitive pronephric urogenital system of the primitive fish by a new mesonephric system typical of the Ichthyopsida, and that in turn replaced by the metanephric system of reptiles and mammals, or else the whole logical argument for Evolution in the field of Comparative Anatomy is wrong. And either exactly this same order of succession, with each system having its own detailed structures, is proven by the embryological history of the urogenital systems, or else the whole idea expressed in the Biogenetic Law is wrong. But if these arguments for the fact of Evolution in these fields of Comparative Anatomy and Embryology are valid, then it must follow that at least the metanephric system is a brand new set of excretory tubules with a brand new pair of excretory ducts, the ureters. Some way there must have been an evolution through the early non-functional stages of the system. Being non-functional there was no selective value inherent in their presence. Neither Lamarckism nor Darwinism could have been instrumental in the development of these structures to the point where they could have been of positive functional value to their possessors.

A very similar argument is afforded in the same two fields by the heart. The argument for Comparative Anatomy, and as checked in the field of Embryology, is that in the beginning of Vertebrate Evolution the heart was a simple tube modified into contractile chambers, the sinus venosus collecting the blood, forcing

it forward into the single auricle, and it in turn into the single ventricle. In evolving from the lower fish to the higher fish and Amphibia the auricle became divided into two. Why does it become so divided? Potentially it is a most important forward step, but so long as both oxygenated and unoxygenated bloods are completely mixed in the single ventricle, where is there any selective value? If of no selective value, why did it evolve? Specialization continued through the partition of the single ventricle into two, the division being quite incomplete in some reptiles and complete in others and in mammals. But I submit that until the division of the ventricle is half complete there can be no appreciable selective value. Which means that 75% of the whole evolution of a two-chambered heart into a four-chambered one has been completed before there can be any appreciable selective value. And if 75% of this evolution is due to something other than Lamarckian or Darwinian Evolution, it seems reasonable to assume that the final 25% or so of Evolution would be due to the same method as the rest of it. As before stated, this evolution could be by Mutation, but if so it is orthogenetic mutation.

Many instances of Orthogenesis among Foraminifera are listed by Galloway (1933), and these are quite like my own observations upon Bryozoa and Brachiopoda in that specializations show no evidence of having been initiated by environmental stimuli activating latent tendencies, since the specializations in that case should occur simultaneously in different related lines of descent. Actually a given specialization may begin in separate but related genealogies at different times, in different places, and under different environmental conditions as far as these may be judged by the character of the sediments and the nature of the associated life. This is particularly true in such cases as in the brachiopod genus Spirifer, using that term in the old broad sense, where at least five lines of descent, now mostly known by subgeneric terms, have all attempted at one time or another to become spinose.

To include this type of specialization would expand the definition of Orthogenesis to include not only the cases where a co-ordinated group of specializations progresses through geological time, as in the evolution of the horse, and those cases of single specializations, but also those cases just mentioned where there is a tendency for the same specialization to appear in separate but related genealogies at different times, in different places, and under different environmental conditions.

These specializations need not be purely linear and isolated, but may show digressions from the main line as in the camels, elephants, horses, etc., each digression being possibly orthogenetic in its nature.

At various times H. F. Osborn has stressed the invariable nature of these straight lines as he observed them in fossil vertebrates. But in invertebrates, especially brachiopods, my observation has been that such development has not been along the narrow, straight, undeviating path implied by critics and protagonists alike. While the general course was more or less straight, along that course we find at any given time a quite wide range of variability of a given character.

To me the progression of life through the ages has been quite analogous to that of a moving herd of cattle on the open range. Individuals may zig-zag from one side to another, there may be a decided milling around, separate groups may leave and go off on their own tangents, yet the movement of the herd as a whole is definitely in a given direction.

I am not even implying in this simile that there is a driver behind this hypothetical herd, nor behind these progressive specializations which are largely independent of the environment, and are controlled by it only when fairly well developed.

But we may ask, just what *is* behind these cases of Orthogenesis? Is there a driver behind the moving herd, an Intelligent Design behind evolving life? Or

is there an inner urge of some kind present? In the herd we can understand the origin of such an urge in hunger, thirst, protection, etc. In life's evolution the origin of such a progression, the cause of Orthogenesis, is a mystery.

There does seem to be something within the lineage and within the individual organism that is struggling for expression, but of it's nature and its origin, and just how that urge got into the germ plasm, we know nothing, for here we depart from science and enter the field of purely speculative metaphysical philosophy.

Scientists have been hypersensitive with respect to any idea of a teleological influence, of an Intelligent Design, behind the development we call Orthogenesis, and apparently this has in part explained why they have been so slow to accept the challenge of the implications involved. The reason for this reluctance is to be found in the practically complete stagnation of science from the death of Galen, 200 A. D. to the renaissance of Science in 1543, during which period of the Dark Ages, the Age of Scholasticism, and even later, it was assumed that everything worth knowing had been known to the ancient prophets, the Greek philosophers, and the early Christian fathers.

However, it is not necessary for Science to adopt a teleological explanation. If that doesn't have an appeal there is always the possibility of following the dictum of the unknown writer of the ancient medical school of Hippocrates at Cos. Writing upon epilepsy about 200 B. C. he said, "But if they called everything divine merely because they did not understand it, why, there would be no end of divine things. . . . In nature all things are alike in this, that they can all be traced to preceding causes." In other words, one can leave it an open question, as did H. F. Osborn when he once called it "the great unknown factor in Evolution."

It is true that if we collect one kind of evidence we can quite logically justify a belief in an Intelligent Design. If we collect another type of evidence we can justify the opposite. However, if we put all the evidence together, as a scientist must, these two collections cancel each other very nicely, and we are left where we started. But we still have the fact of Orthogenesis.

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